

## REMARKS

Claims 1-20 are pending in this application. Claim 1 is the sole independent claim. Claim 6 has been amended to recite "the counter electrode" in place of "a conductive substrate" for purposes of clarification and not to limit its scope. This amendment finds support at page 19, lines 2-5 of the specification. Claim 9 has been amended to recite "the metal oxide semiconductor mesoporous film" in place of "a metal oxide semiconductor mesoporous film", as suggested by the Examiner, for purposes of clarification and not to limit its scope. The amendments to the claims do not introduce any new matter and do not raise any new issues. As a minimum, the amendments to the claims reduce the issues for Appeal in the event an Appeal is needed.

The objection to Claim 9 and rejection of Claim 6 under 35 USC §112, second paragraph have been overcome by the above amendments to these claims.

Claims 1-5 and 9-16 are rejected under 35 USC 103 as being obvious over WO 2004/017452 to Yoshikawa et al. in view of US Patent 5,188,768 to Sotomura. The cited references do not render unpatentable the present invention.

As is clear from the disclosure of the present application, especially from claims 1 and 5, important aspects of the present invention reside in the electrolyte comprising: (i) a layered clay mineral and/or an organically modified layered clay mineral; and (ii) an ionic liquid.

This electrolyte is useful, as an electrolyte layer, for a photovoltaic device in which the electrolyte layer is located between a photoelectrode and a counter electrode. As disclosed on page 14, lines 5 - 26 of the specification, the "ionic liquid" (e.g., quaternary ammonium salts, imidazolium salts, pyridium salts, pyrrolidinium salts, piperidinium salts) is known in the art and, as shown by the term "liquid", exists in the form of a liquid under an ambient condition (i.e., a room temperature) and, therefore, when used as an electrolyte, the use of a solvent is not necessary, unlike the other conventional electrolytes known in the art. This is completely absent in the cited references.

Yoshikawa et al relate to an electrolyte for dye-sensitized solar cells wherein an oxidation-reduction is carried out by a vulcanized rubber, a polyphosphazene, a porous body comprising a high molecular material comprising a high molecular material which has a three-dimensional continuous network skeleton structure or an EVA resin film.

According to the Office Action, Yoshikawa et al. teach an electrolyte comprising a oxidation-reduction substance containing an ionic liquid, e.g. 1,2 dimethyl-3-propylimidazolium iodide, carried by a vulcanized rubber containing clay (abstract: [0112]; [0200 - 0207]), although Yoshikawa et al do not expressly teach a layered clay mineral and/or an organically modified layered clay mineral.

However, this is not correct and differs from the present invention in the following points:

(i) 1,2-dimethyl-1,3-propyl imidazolium iodide is not an ionic liquid, because the melting point of the 1,2-dimethyl-1,3-propyl imidazolium iodide (i.e., oxidation-reduction substance) is in the form of a solid (i.e., white-light yellow, crystal-powder) at 20°C, which is not a liquid under an ambient condition (See the enclosed Reference 1, i.e., section IX on page 2 of "Material Safety Data Sheet").

Thus, Yoshikawa et al neither disclose nor teach the use of the ionic liquid.

(ii) Yoshikawa et al. neither disclose nor teach the use of the layered clay mineral (and/or the organically modified layered clay mineral, the same hereinbelow) in the ionic liquid.

Yoshikawa et al. merely disclose the use of clay (note: not the layered clay mineral) in the vulcanized rubber. As is well known in the art, the "clay" mentioned in Yoshikawa et al is used, as a filler such as carbon black, silica, calcium carbonate and the like. In addition, the vulcanized rubber is not used in the present invention.

Consequently, the use of the ionic liquid and the use of the layered clay mineral (even the clay) in an ionic liquid are completely absent in Yoshikawa et al.

Sotomura does not overcome the above discussed deficiencies of Yoshikawa et al. with respect to rendering unpatentable the present invention. Sotomura relates to a solid form electrolyte composite comprising an ion-exchanging layered compound (e.g. a clay material) and an ionic material MX (e.g., LiI, LiClO<sub>4</sub>, LiCF<sub>3</sub>SO<sub>3</sub>, ...).

This is completely different from the present invention. Especially, the use of the layered clay mineral in an ionic liquid is completely absent in Sotomura.

Claims 6-8 and 17-20 are rejected under 35 USC 103 as being obvious over WO 2004/017452 to Yoshikawa et al. in view of US Patent 5,188,768 to Sotomura and of US patent application publication 2005/0072462 to Kang et al.

Kang does not overcome the above discussed deficiencies of Yoshikawa et al. and Sotomura with respect to rendering unpatentable the present invention. Kang et al were relied upon for a disclosure of a solid state dye-sensitized solar cell in which, a counter electrode coated with polyaniline can be employed (abstract, [0024]).

However, again the use of the layered clay mineral in an ionic liquid is completely absent in Kang et al, as is the case with the other references. Consequently, the use of the layered clay mineral and/or the organically modified clay mineral in an ionic liquid in the present invention is completely absent in the cited references or any combination thereof. Accordingly, claims 6-8 and 17-20 are patentable for at least those reasons as to why claim 1 is patentable.

Concerning obviousness, *Graham V. John Deere*, 383 U.S. 1, 148 U.S.P.Q. 459 (1966) outlines the approach that must be taken when determining whether an invention is obvious. In *Graham*, the Court stated that a patent may not be obtained if the subject matter would have been obvious at the time the invention was made to a person having ordinary skill in the art, but emphasized that nonobviousness must be determined in the light of inquiry, not quality. Approached in this light, §103 permits, when followed realistically, a more practical test of patentability. In accordance with *Graham*, three inquiries must be made in determining whether an invention is obvious:

- (1) The scope and content of the prior art are to be determined.

- (2) The difference between the prior art and the claims at issue are to be ascertained.
- (3) The level of ordinary skill in the pertinent art resolved.
- (4) Evaluating evidence of secondary considerations, such as commercial success, long felt but unsolved needs and failure of others, etc. Also see *KSR Int'l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727 (2007).

Against this background, the obviousness or nonobviousness of the subject matter is determined. Secondary considerations, such as unexpected results, commercial success, long felt but unsolved needs, failure of others, etc., can be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented.

In conjunction with interpreting 35 U.S.C. §103 under Graham, the initial burden is on the Patent Office to provide some suggestion of the desirability of doing what the inventor did, i.e. the Patent Office must establish a *prima facie* case of obviousness. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention, or the Patent Office must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references.

To establish a *prima facie* case of obviousness, three basic criteria must be met:

1. There must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference.
2. There must be a reasonable expectation of success.
3. The prior art reference (or references when combined) must teach or suggest all the claim limitations.

The mere fact that the cited art may be modified in the manner suggested in the Office Action does not make the modification obvious, unless the cited art suggest the desirability of the modification or adequate rationale exists to do so. No such suggestion appears in the cited art in

this matter nor has the requisite rationale been adequately articulated. . The Examiner's attention is kindly directed to *KSR Int'l Co. v. Teleflex, Inc.*, supra; *In re Lee* 61 USPQ2d 1430 (Fed. Cir. 2002), *In re Dembiczak et al.* 50 USPQ2d. 1614 (Fed. Cir. 1999), *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984), *In re Laskowski*, 10 USPQ2d. 1397 (Fed. Cir. 1989) and *In re Fritch*, 23, USPQ2d. 1780 (Fed. Cir. 1992).

Also, the cited art lacks the necessary direction or incentive to those of ordinary skill in the art to render a rejection under 35 USC 103 sustainable. The cited art fails to provide the degree of predictability of success of achieving the properties attainable by the present invention as discussed above needed to sustain a rejection under 35 USC 103. See *KSR Int'l Co. v. Teleflex, Inc.*, supra; *Diversitech Corp. v. Century Steps, Inc.* 7 USPQ2d 1315 (Fed. Cir. 1988), *In re Mercier*, 187 USPQ 774 (CCPA 1975) and *In re Naylor*, 152 USPQ 106 (CCPA 1966).

Moreover, the properties of the subject matter and improvements and advantages which are inherent in the claimed subject matter and disclosed in the specification are to be considered when evaluating the question of obviousness under 35 USC 103. See *KSR Int'l Co. v. Teleflex, Inc.*, supra; *Gillette Co. v. S.C. Johnson & Son, Inc.*, 16 USPQ2d. 1923 (Fed. Cir. 1990), *In re Antonie*, 195, USPQ 6 (CCPA 1977), *In re Estes*, 164 USPQ 519 (CCPA 1970), and *In re Papesch*, 137 USPQ 43 (CCPA 1963).

No property can be ignored in determining patentability and comparing the claimed invention to the cited art. Along these lines, see *In re Papesch*, supra, *In re Burt et al.*, 148 USPQ 548 (CCPA 1966), *In re Ward*, 141 USPQ 227 (CCPA 1964), and *In re Cescon*, 177 USPQ 264 (CCPA 1973). In view of the above, consideration and allowance are respectfully solicited.

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In the event the Examiner believes another interview might serve in any way to advance the prosecution of this application, the undersigned is available at the telephone number noted below.



The Office is authorized to charge any necessary fees due with this paper to Deposit Account No. 22-0185, under Order No. 21713-00032-US1 from which the undersigned is authorized to draw.

Dated: May 12, 2011

Respectfully submitted,

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# Material Safety Data Sheet

HAZARD WARNINGS	RISK PHRASES	PROTECTIVE CLOTHING
	Irritating to skin, eyes, and the respiratory system.	

## Section I. Chemical Product and Company Identification

Chemical Name	<b>1,2-Dimethyl-3-propylimidazolium Iodide</b>		
Catalog Number	D3903	Supplier	TCI America 9211 N. Harborside St. Portland OR 1-800-423-8616
Synonym	1H-Imidazolium, 1,2-dimethyl-3-propyl-, iodide (1:1) (CA INDEX NAME)		
Chemical Formula	C <sub>8</sub> H <sub>13</sub> N <sub>2</sub> I		
CAS Number	218151-78-1		
		Chemical Abstracts (800) 421-9300 (U.S.) (703) 527-3867 (International)	

## Section II. Composition and Information on Ingredients

Chemical Name	CAS Number	Percent (%)	TLV/PEL	Toxicology Data
1,2-Dimethyl-3-propylimidazolium Iodide	218151-78-1	Min. 98.0 (HPLC,T)	Not available.	Not available.

## Section III. Hazards Identification

Acute Health Effects	Irritating to eyes and skin on contact. Inhalation causes irritation of the lungs and respiratory system. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering. Follow safe industrial hygiene practices and always wear proper protective equipment when handling this compound.
Chronic Health Effects	CARCINOGENIC EFFECTS : Not available. MUTAGENIC EFFECTS : Not available. TERATOGENIC EFFECTS : Not available. DEVELOPMENTAL TOXICITY: Not available. Repeated or prolonged exposure to this compound is not known to aggravate existing medical conditions.

## Section IV. First Aid Measures

Eye Contact	Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.
Skin Contact	In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention.
Inhalation	If the victim is not breathing, perform mouth-to-mouth resuscitation. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, oxygen can be administered. Seek medical attention if respiration problems do not improve.
Ingestion	INDUCE VOMITING by sticking finger in throat. Lower the head so that the vomit will not reenter the mouth and throat. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Examine the lips and mouth to ascertain whether the tissues are damaged, a possible indication that the toxic material was ingested; the absence of such signs, however, is not conclusive.

## Section V. Fire and Explosion Data

Flammability	May be combustible at high temperature.	Auto-Ignition	Not available.
Flash Points	Not available.	Flammable Limits	Not available.
Combustion Products	These products are toxic carbon oxides (CO, CO <sub>2</sub> ), nitrogen oxides (NO, NO <sub>2</sub> ), halogenated compounds.		
Fire Hazards	Not available.		
Explosion Hazards	Risks of explosion of the product in presence of mechanical impact: Not available. Risks of explosion of the product in presence of static discharge: Not available.		
Fire Fighting Media and Instructions	SMALL FIRE: Use DRY chemical powder. LARGE FIRE: Use water spray, fog or foam. DO NOT use water jet. Consult with local fire authorities before attempting large scale fire-fighting operations.		

**Section VI. Accidental Release Measures****Spill Cleanup Instructions**

Irritating material.

Use a shovel to put the material into a convenient waste disposal container. Finish cleaning the spill by rinsing any contaminated surfaces with copious amounts of water. Consult federal, state, and/or local authorities for assistance on disposal.

**Section VII. Handling and Storage****Handling and Storage Information**

IRRITANT. Keep away from heat. Mechanical exhaust required. When not in use, tightly seal the container and store in a dry, cool place. Avoid excessive heat and light. Do not breathe dust. Always store away from incompatible compounds such as oxidizing agents.

**Section VIII. Exposure Controls/Personal Protection****Engineering Controls**

Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

**Personal Protection**

Splash goggles. Lab coat. Dust respirator. Boots. Gloves. Suggested protective clothing might not be sufficient, consult a specialist BEFORE handling this product. Be sure to use a MSHA/NIOSH approved respirator or equivalent.

**Exposure Limits**

Not available.

**Section IX. Physical and Chemical Properties****Physical state @ 20°C**

Solid. (White - light yellow, crystal - powder.)

**Solubility**

Soluble in water.

**Specific Gravity**

Not available.

**Molecular Weight**

266.12

**Partition Coefficient**

Not available.

**Boiling Point**

Not available.

**Vapor Pressure**

Not applicable.

**Melting Point**

Not available.

**Vapor Density**

Not available.

**Refractive Index**

Not available.

**Volatility**

Not available.

**Critical Temperature**

Not available.

**Odor**

Not available.

**Viscosity**

Not available.

**Taste**

Not available.

**Section X. Stability and Reactivity Data****Stability**

This material is stable if stored under proper conditions. (See Section VII for instructions)

**Conditions of Instability**

Avoid excessive heat and light.

**Incompatibilities**

Reactive with oxidizing agents.

**Section XI. Toxicological Information****RTECS Number**

Not available.

**Routes of Exposure**

Eye Contact. Ingestion. Inhalation.

**Toxicity Data**

Not available.

**Chronic Toxic Effects**

CARCINOGENIC EFFECTS : Not available.

MUTAGENIC EFFECTS : Not available.

TERATOGENIC EFFECTS : Not available.

DEVELOPMENTAL TOXICITY: Not available.

Repeated or prolonged exposure to this compound is not known to aggravate existing medical conditions.

**Acute Toxic Effects**

Irritating to eyes and skin on contact. Inhalation causes irritation of the lungs and respiratory system. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Follow safe industrial hygiene practices and always wear proper protective equipment when handling this compound.

**Section XII. Ecological Information****Ecotoxicity**

Not available.

**Environmental Fate**

Not available.



**Section XIII. Disposal Considerations****Waste Disposal**

Recycle to process, if possible. Consult your local regional authorities. You may be able to dissolve or mix material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber system. Observe all federal, state and local regulations when disposing of the substance.

**Section XIV. Transport Information****DOT Classification**

Not a DOT controlled material (United States).

**PIN Number**

Not applicable.

**Proper Shipping Name**

Not applicable.

**Packing Group (PG)**

Not applicable.

**DOT Pictograms****Section XV. Other Regulatory Information and Pictograms****TSCA Chemical Inventory (EPA)**

This product is NOT on the EPA Toxic Substances Control Act (TSCA) inventory. The following notices are required by 40 CFR 720.96 (C) for those products not on the inventory list:

- (i) These products are supplied solely for use in research and development by or under the supervision of a technologically qualified individual as defined in 40 CFR 720.0 et seq.
- (ii) The health risks of these products have not been fully determined. Any information that is or becomes available will be supplied on an MSDS sheet.

**WHMIS Classification (Canada)**

Not available.

**ECNECS Number (EEC)**

Not available.

**EEC Risk Statements**

R36/37/38- Irritating to eyes, respiratory system and skin.

**Japanese Regulatory Data**

Not available.

**Section XVI. Other Information****Version L8**

Validated on 1/8/2010.

Printed 1/8/2010.

**Notice to Reader**

TCI laboratory chemicals are for research purposes only and are NOT intended for use as drugs, food additives, household, or pesticides. The information herein is believed to be correct, but does not claim to be all inclusive and should be used only as a guide. Neither the above named supplier nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All chemical reagents must be handled with the recognition that their chemical, physiological, toxicological, and hazardous properties have not been fully investigated or determined. All chemical reagents should be handled only by individuals who are familiar with their potential hazards and who have been fully trained in proper safety, laboratory, and chemical handling procedures. Although certain hazards are described herein, we can not guarantee that these are the only hazards which exist. Our MSDS sheets are based only on data available at the time of shipping and are subject to change without notice as new information is obtained. Avoid long storage periods since the product is subject to degradation with age and may become more dangerous or hazardous. It is the responsibility of the user to request updated MSDS sheets for products that are stored for extended periods. Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment (e.g. protective goggles, protective clothing, breathing equipment, facial mask, face hood). For proper handling and disposal, always comply with federal, state, and local regulations.